DATA ON THE GEOLOGICAL AND MINERALOGICAL KNOWLEDGE OF LOWER PANNONIAN STRATA IN THE MISKOLC — GÖRÖMBÖLY AREA

by

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The Department of Silicate-Chemistry of the Central Institute for Silicate Research carried out, in the years 1962—1965, an exploration for raw-materials in the region of the Csoznyatető and Lengyelszótető heights, in the neighbourhood of Miskolc-Görömböly. In the course of prospecting — besides supplying the clay need of the "Hejőcsaba Cement and Lime Works" and the geological knowledge of the region — we obtained with the great scale examintation of materials, a detailed information about the mineralogical-petrographical setting of the Lower Pannonian formation in the southern region of Miskolc [GY. VITÁLIS—J. HEGYI, 1965].

GEOLOGICAL CONDITIONS OF THE AREA

Geological structure: The Csoznyatető-Lengyelszótető and their neighbourhood is situated in the hill region, built from Neogene top formations, east of the Mesosoic basement of the Bükk Mountains and west of the valley of the river Sajó *(Fig. 1)*.

Among the *Neogene* top formations, the Middle-Miocene sand, clay, sandstone and brown coal, further the upper-rhyolite tuff, andesite tuff and agglomerate as well as limestone and andesite-gravel, respectively, sand and clay belonging to the Sarmatian, finally Lower Pannonian sand and clay layers crop out on the surface.

Formations of the *Quaternary* are represented by Pleistocene brown-clay covering the greatest part of the area and by Holocene stream deposit and flood-area sediments filling the valley soles. [Z. SCHRÉTER 1925, 1939, 1943, 1960, T. TAKÁTS, 1964, GY. VITÁLIS—J. HEGYI, 1965].

Mountain Structure. The faulted forms are characteristical for the area. The NNE-SSW, NW-SE and N-S orientated faults, as already shown by the directions of surface drainage, cut the hilly region in smaller and greater blocks. Dip of the Neogene layers is generally 10—15° SE.

The areas present relief was formed in the Quaternary, by way of erosion. The effect of the erosion can mostly be seen beside the supposed SW-NE directed, parallel faults. The valley top of the small, temporary waterflow with source on the Csoznyatető area, needs attention. The face of this was significantly changed during the heavy rainfalls of 1965 in comparison to the past drier years.

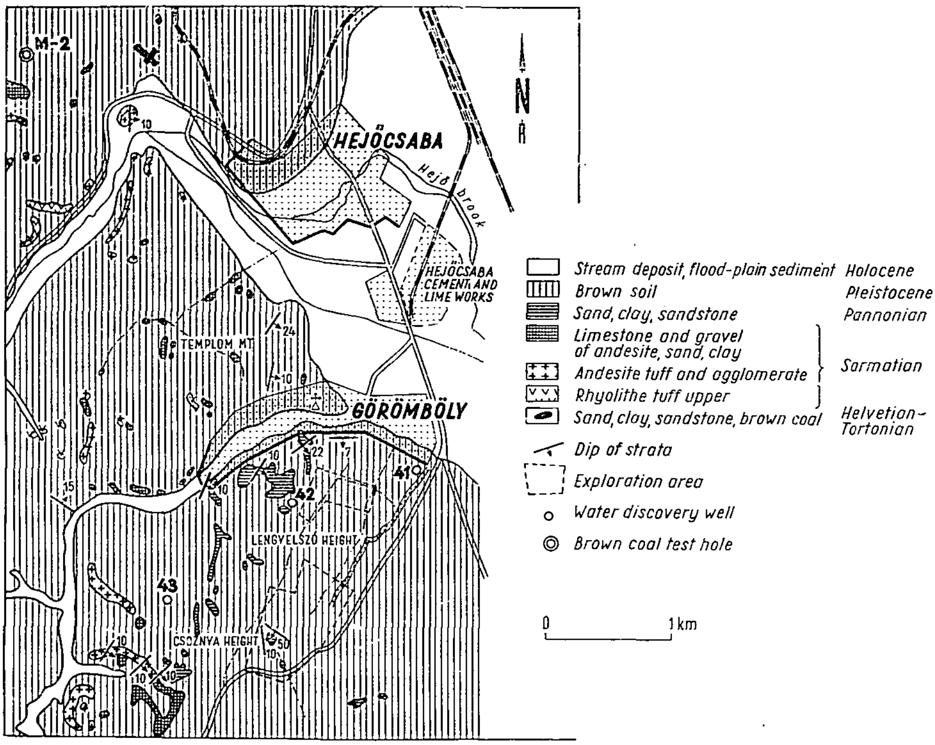


Fig. 1. Sketching geological map of the sorroundings of Miskolc-Görömböly (after Z. SCHRÉTER).

GEOLOGICAL SETTING OF THE PROSPECTED AREAS

Geological conditions. In the geological setting of the prospected Csoznyatető and Lengyelszótető area, Lower Pannonian and Pleistocene formations are taking part.

The *Lower Pannonian formation* explored by 10—30 m deep borings, contains clastic sedimentary rocks of varied petrographical development. Yellow, brown and grey coloured silty clay, clayey silt, silt with rock flour, silty rock flour, sandy rock flour, sand with rock flour and (fine) sand layers are alternating with one another.

Upon the Lower Pannonian strata 0,4—9,2 m thick Pleistocene cover is deposited consisting mostly of brown, reddish brown, less brownish yellow and brownish grey silty clay, clayey silt and silt with rock flour. The Pleistocene cover of clayey development — being practically a useful material for the cement industry too, — are shown on the clay thickness map *(Fig. 3)* together with the clayey Pannonian layers.

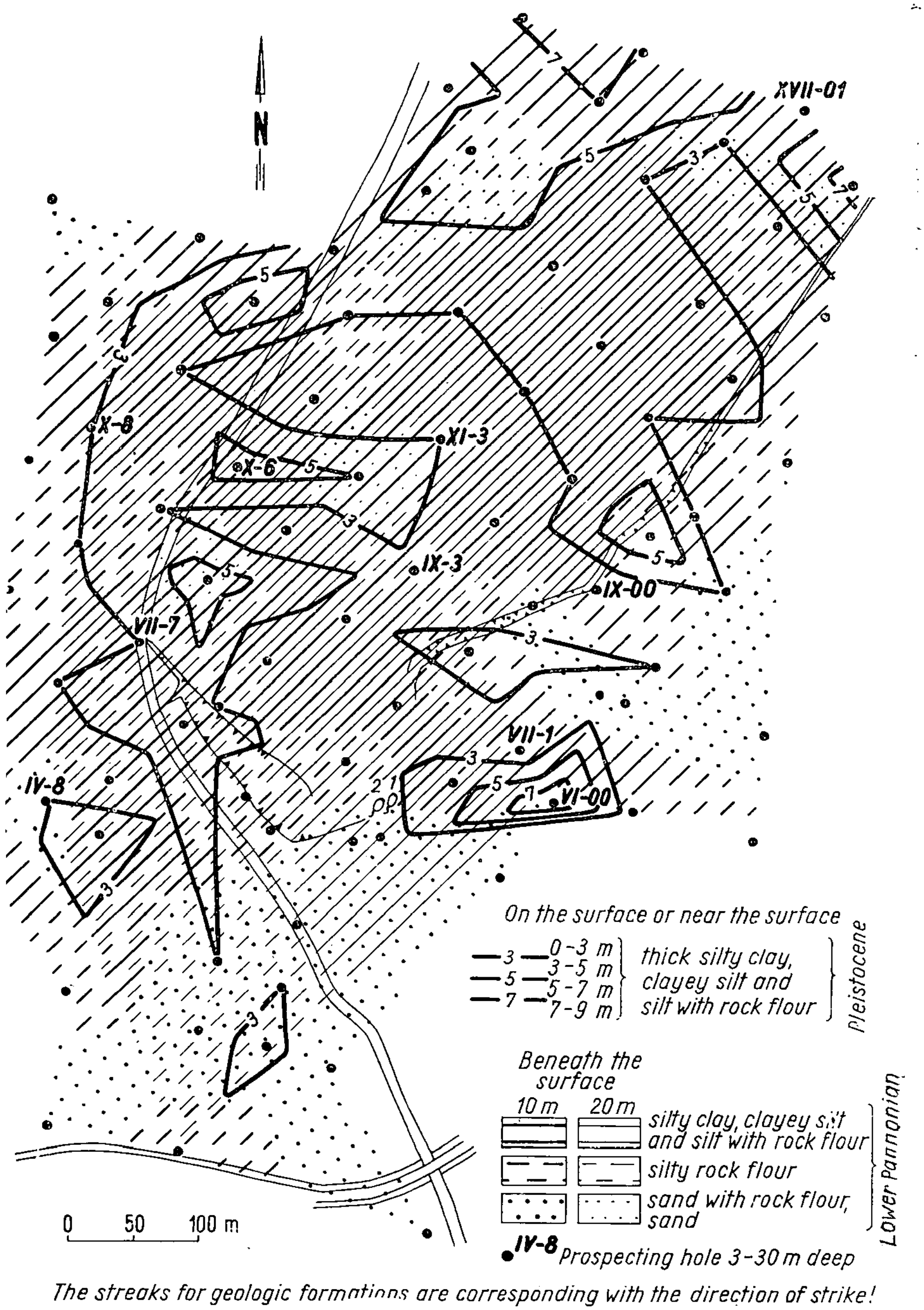


Fig. 2. Engineer-geological map of the Csoznyatető exploration area.

The general sequence of formations in the areas of clayey development, to the depth of 30 m, correlating well log datas, is the following:

Below the brown and mildy reddish brown clayey Pleistocene top formation, 3—5 m thick in average, generally to 20 m depth silty clay — in places with interbedded silty rock flour, — clayey silt and rock floured silt layers, characterized with yellowish brown or brownish yellow tint are alternating with one another. Under 20 m depth (till 30 m) grey coloured more uniformly developed silty clay, clayey silt or rock floured silt is bedded.

The grey coloured clayey layers bedded below 20 m represent a greater, connected sequence of strata toward the depth, based on the observations in the claypit of the Görömböly brick-works and on the log of the Miskolc — 42 watertesting well.

To justify the age of the layers, M. SZÉLES determined from the materials of the Csoznyatető VI-00, VII-7, IX-00, X-6, X-8, XI-3 and Lengyelszótető L-7 borings the following Ostracoda species:

Candona labiata ZAL., *Candona (Lineocypris) trapezoidea* ZAL., *Candona* sp., *Paracypria (Pontonella) acuminata* ZAL., *Amplocypris pannonica juv.* ZAL., *Amplocypris sinuosa* ZAL., *Amplocypris* sp., *Cyprideis heterostigma obesa* REUSS, *Cyprideis macrostigma* koll., *Cyprideis pannonica* MÉHES, *Cyprideis sulcata* ZAL., *Cyprideis* sp., *Loxoconcha* sp., *Leptocythere parallela* MÉHES, *Leptocythere* sp., *Hemicythere lörentheyi* MÉHES and *Hemicythere* sp.

The enumerated Ostracoda species give ample proof of the formations Lower Pannonian age.

The palynological investigations, made from the material of the Csoznyatető IV-8 and X-8 borings, during the complex examinations, are presented in the paper of Mrs. MARIA MIHÁLTZ [1966].

The geological conditions of the Csoznyatető prospecting area are displayed on the engineer-geological map *(Fig. 2)* designed upon the prospecting holes. It presents the thickness of the Pleistocene capping and the rock materials deposited at 10 and 20 m below the surface.

The total thickness of useful material is displayed on the isolith map of the clayey strata. The clay isolith map of the Lengyelszótető prospecting area is shown in *Fig. 3*.

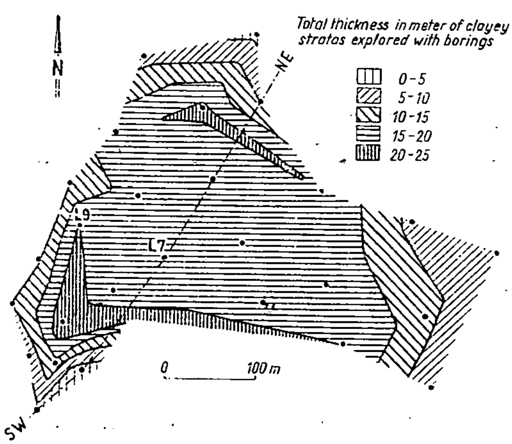


Fig. 3. Map of clay thickness of the Lengyelszótető exploration area

For the qualitative presentation of rock materials building up the area, SM (silicate module) maps for the Csoznyatető area and SM profiles for the Lengyelszótető area were constructed. These illustrate first of all the industrial utilisability of the raw-material and in the same time the petrographical setting of the area.

The SM maps of Csoznyatető were constructed with interpolation on the basis of the SM values of rock materials from 5, 10 *(Fig. 4)*, 15 and 20 m depths.

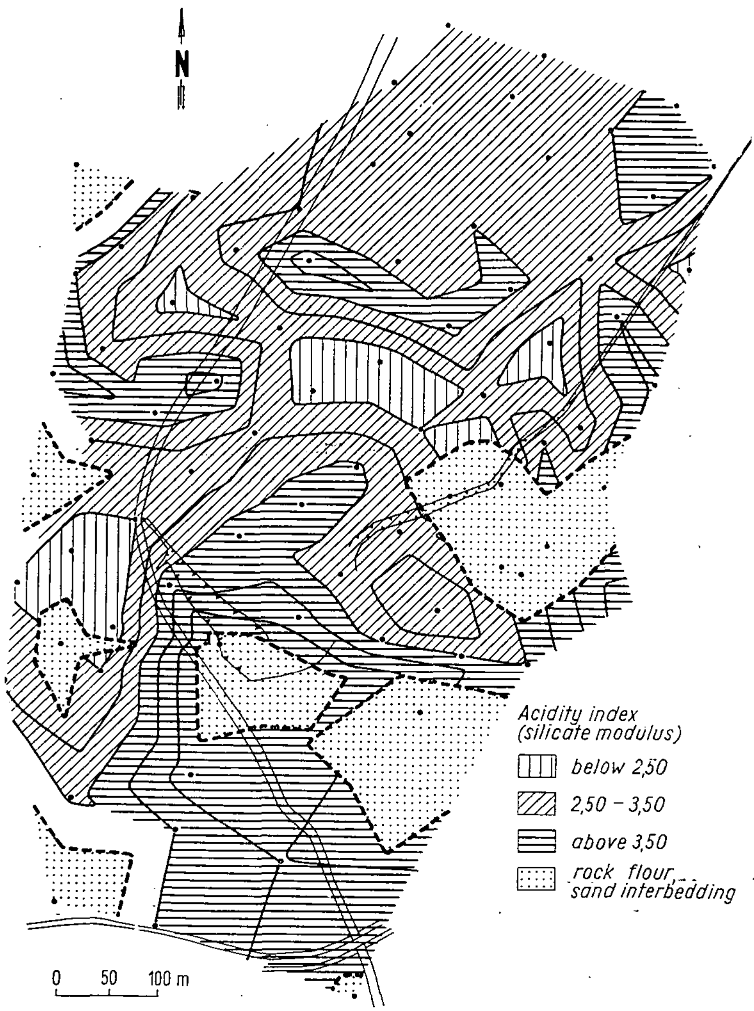


Fig. 4. SM (silicate module) map, 10 m below the surface, of the Csoznyatető exploration area.

The drawing of the boundaries of clay quality was coordinated with the geologic profiles from the same place, during the completing of the SM profiles of Lengyelszótető *(Fig. 6)*. So the geological and SM profiles are completing each other and give a good information — depending upon the possibilities — geologically and technologically.

STRUCTURAL AND BEDDING CONDITIONS

The structural and bedding conditions of both areas explored suit well in the frame outlined dealing with the mountain structure of the area.

The geological block-diagram *(Fig. 5)* of Csoznyatető — designed on base of test borings — and the profile on *Fig. 6*, chosen from geological sections made from the Lengyelszótető area, illustrate excellently the geological and bedding conditions.

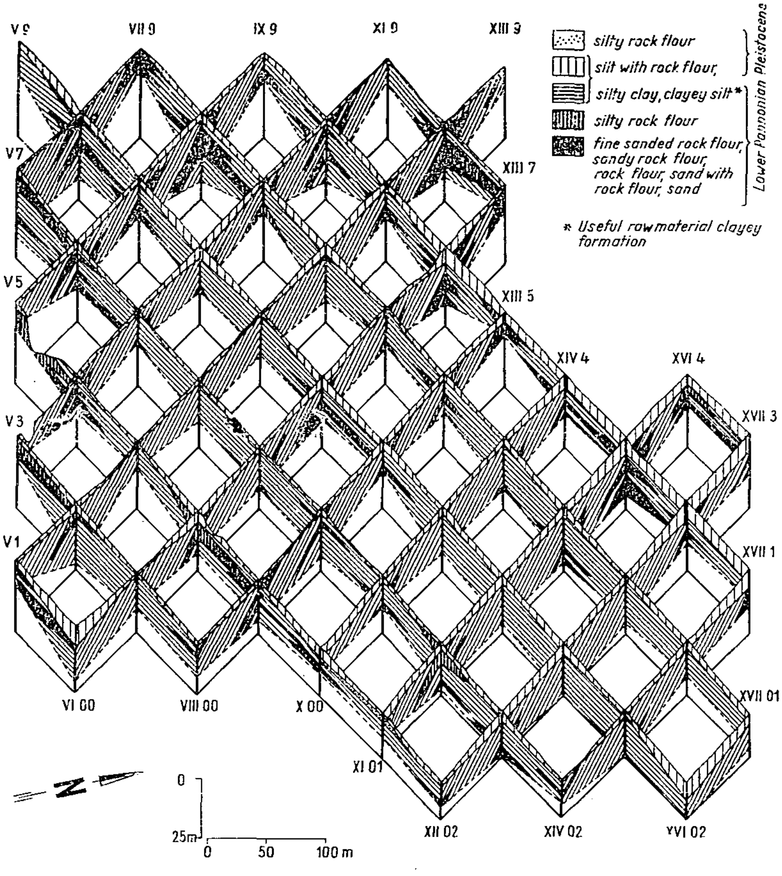


Fig. 5. Geological block diagram of the Csoznyatető exploration area

The dip values, by designing the block diagram and other profiles were taken into account with the average SE (135°) direction — characteristic of the area, and with 10°—15° angle of dip.

The silty clay, clayey silt and silt with rock flour strata are shown on the enclosed maps and profiles together and united as clayey layers — as useful raw-materials used in the cement-industry. The structure and bedding of sandy-clayey developed strata is to be seen in excellent outcrops of the clay mine in the Görömböly brickyard. In the series several faults and, mostly in the sandy developed layers, diagonal cross-beddings are to be seen. It is supposed on this base that the same conditions are to be found in the neighbourhood of the outcrop, in the area explored by borings. The cross-bedded and outwedged bedding of the layers concludes partly upon fluvial sediments, partly upon the frequent oscillation of the Pannonian inland sea. The capricious-bedded layers deposited near the shore of the inland see renders the exploration of the massed, petrographically uniformly developed clay strata quite difficult.

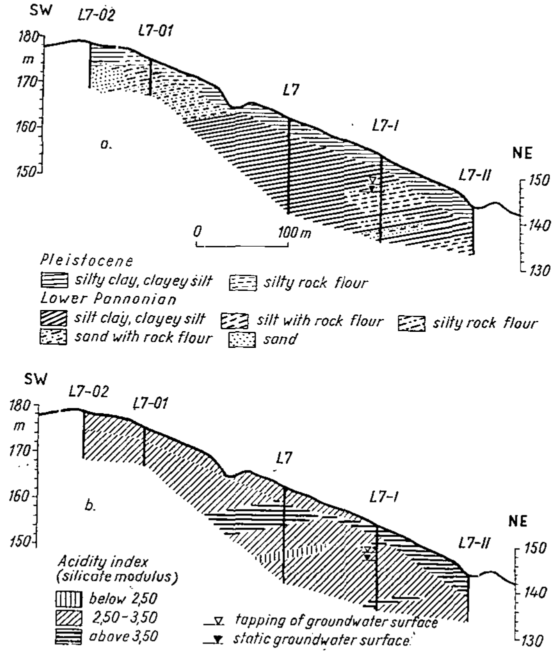


Fig. 6. SW-NE geological (a) and SM (b) profile of the Lengyelszótető exploration area

The area explored by borings is presumably cut by several smaller or greater faults whose location on the map with the help of borings, is so far still impossible.

HYDROGEOLOGICAL CONDITIONS

Surface water. In the gully, coming from the middle part of the Csoznyatető area into approximately NE direction, a bed of a periodical waterflow runs. Besides the rain, two small wells are feeding the periodical waterflow. The well No. 1 is a wild one and the No. 2 is captured with concrete rings. We measured regularly with cubing the two wells rate of flow, in the time between 22.3—12.5. 1965. The result was: 1,8—3,0 lit/min. for the first and 2,5—2,7 lit/min. for the second well.

In the S-N and SSW-NNE running gullies, on the Western part of the Lengyelszótető exploration area, water can only be found after heavy rains or during the snow thawing.

The groundwater, in small depth below the surface, within the Csoznyatető exploration area follows the relief of the surface. The unevenness of groundwater in the Lengyelszótető area reflects upon the capricious structural and bedding conditions of the area.

The static groundwater level is situated mostly above the tapped groundwater level. This indicates that the groundwater is under pressure in consequence of the clay strata clamping.

QUALIFYING TEST OF RAW MATERIAL

A number of 82 borings 3—30 m deep, total 1293 m, in the Csoznyatető prospecting area and 27 borings, 6—25 m deep, total 407 m, in the Lengyelszótető area were accomplished with hand-drill. To decide the appropriateness of the rock material — won by test borings, for the cement-industry, and for the geological knowledge of the territory — we made manysided tests with the samples.

Chemical investigations. From the samples of the two areas 36 total and 465 partial analyses (SiO_2, Al_2O_3, Fe_2O_3 and CaO) were carried out. The average and extreme values of the total analyses are shown in *Table 1.* For the technological classification, and evaluation of reserves, silicate module values (SM) were computed from results of the partial analyses. The results of the total analysis — besides the identification, compared with results of other investigations — were used also for determination of mineral composition.

TABLE 1

*Average and extreme values of chemical analyses**

Csoznyatető	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	SO_3	SM
	Weight %											
Average	6,55	64,04	16,58	4,94	0,56	2,96	1,10	0,92	1,93	0,14	0,52	2,99
Minimum	3,75	52,50	11,10	2,57	0,40	1,00	0,22	0,44	1,17	0,04	0,01	1,91
Maximum	10,98	74,65	19,84	7,20	0,97	7,14	2,46	1,32	2,84	0,30	1,70	4,27
Lengyelszótető												
Average	7,40	61,88	14,59	7,25	—	5,36	0,70	0,90	1,95	—	—	3,05
Minimum	3,92	51,17	9,57	4,86	—	2,93	0,16	0,66	1,17	—	—	1,90
Maximum	11,45	73,74	17,90	9,58	—	8,49	1,57	1,17	2,72	—	—	5,11

* *Remark:* Maximum and minimum values in the Table, are not everywhere datas of the same rock samples.

The distribution of the useful raw materials (silt with rock flour, clayey silt, silty clay) of the two areas based on SM values and the single intervals, respectively, are shown in *Fig. 7*, and comprised as follows:

SM value	<2,0	2,0—3,5	>3,5
Csoznyatető	4%	74%	22%
Lengyelszótető	6%	76%	18%

It is well seen on *Fig. 7* that most of the tested samples are between the SM values 2,0—3,5, further that the SM value of Pleistocene rocks belong into a well limited range. The average of the useful materials weighted SM value, is 2,84 in the Csoznyatető and 3,09 in the Lengyelszótető area.

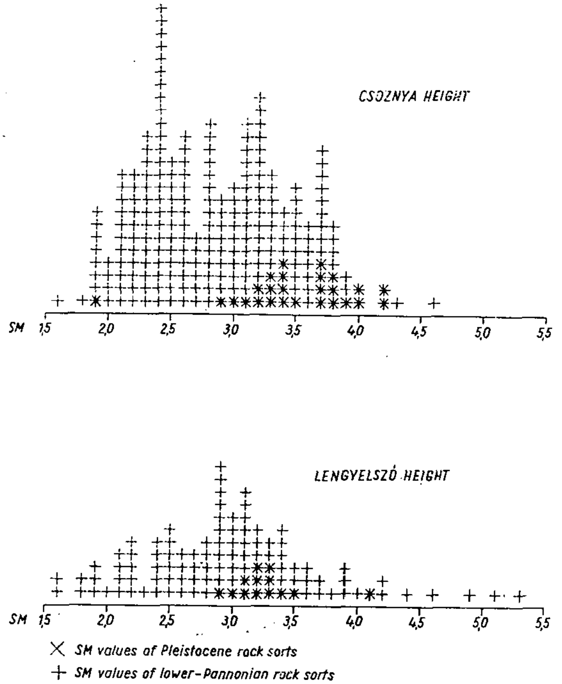


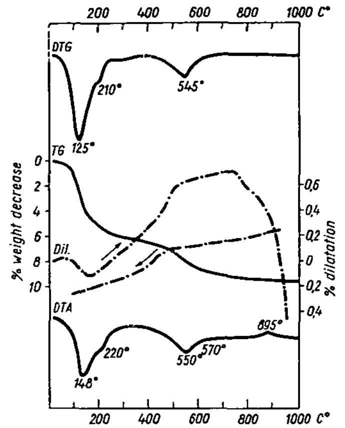
Fig. 7. SM values of the useful raw material.

The SM maps and profiles show that the chemical composition of the materials from both areas are quite heterogeneous near the surface and becomes more homogeneous toward the depth.

Thermal examinations. To ascertain the mineral composition, 70 derivatographic and dilatometric examinations of 70 samples were carried out. The derivatograms were made with the "Derivatograph" according to F. PAULIK—I. PAULIK—L. ERDEY, heating each time 1 g of air-dried material up to 1000 °C. The dilatograms were made with Leitz Bollenrath type dilatometer, with samples 4×4×50 mm in size, heated to 1000 °C.

The derivatograms and dilatograms of two clay samples, characteristic for the Csoznyatető area are shown in *Fig. 8* and *9*.

The great endotherm effect under 300 °C on the DTG and DTA curves, respectively, of both figures, is characteristic of the montmorillonite. The shrinkage within the same temperature interval, seen in the dilatogram, is also typical for the montmorillonite. The endothermic peak at 550 °C on the DTG and DTA curves



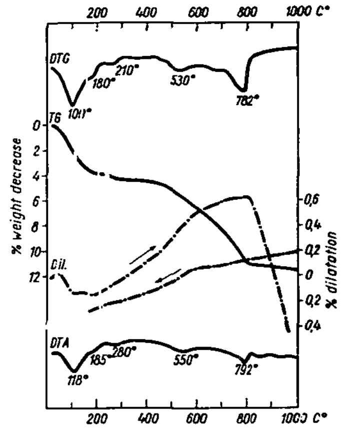


Fig. 8. Thermal curves of the Lower Pannonian silty clay, from 11,0 m depth. No. IX-3 boring of Csoznyatető.

Fig. 9. Thermal curves of the Lower Pannonian silty clay, from 17,0 m depth. No. X-6 boring of Csoznyatető.

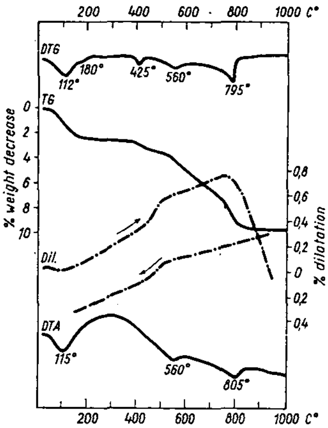
indicates the loss of constitutional water of illite and poorly crystallized montmorillonite. In the low-temperature range sorption of Ca^{2+} and Mg^{2+} ions leads to a double-peaked endothermic reaction. One peak derives from the interlayer water of the clay mineral and the other originates in the hydration water of the sorbed bivalent cations. The dilatogram of the two materials is very similar. The initial shrinkage is followed by the dilatation of the illite and after the breakdown of the crystal lattice (at about 850—900 °C) an abrupt shrinkage can be observed. The bend on the cooling curve of the dilatogram, at about 550 °C (modification transformation) verifies the presence of quartz.

The endotherm effect at about 800 °C on the DTG and DTA curves *(Fig. 9)* originates in the decomposition of calcite. This is also connected with loss of weight (see curve TG).

A further thermogram of a sample typical for the area is shown in *Fig. 10.* This is richer in quartz and contains less clay mineral than the two former materials. Its clay minerals are also of montmorillonite and illite-type. The character of the thermogram in *Fig. 11* indicates the presence of montmorillonite, calcite and quartz and the exotherm peaks on the DTA curves point partly to organic material (330 °C) partly to pyrite (above 400 °C), respectively.

In thermograms of the samples of both areas bends relating to amorphous material of organic origin are common.

Two thermograms made from the characteristic material of the Lengyelszótetö area are shown in *Figs. 12* and *13*. On the basis of the curve in *Fig. 12* the clay mineral of the rock is illite, demonstrated by the well-marked endotherm peak at



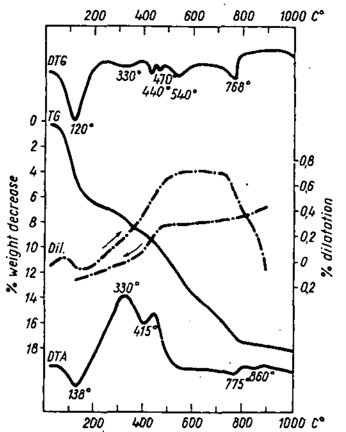
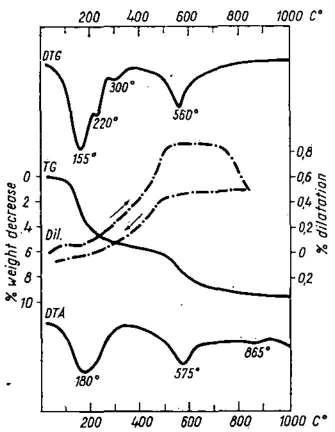


Fig. 10. Thermal curves of the Lower Pannonian silt with rock flour, from 25,0 m depth, No. X-6 boring, Csoznyatető.
Fig. 11. Thermal curves of the Lower Pannonian silty clay, from 8,0 m depth. No. VII-1 boring. Csoznyetető

570 °C. The initial range of the dilatation curve did not show montmorillonite, the cooling curve, however, indicates a greater quantity of quartz.

The sample shown in *Fig. 13* contains illite and a smaller quantity of montmorillonite. Above 300 °C on the DTG and DTA curves a pronounced endothermic peak is to be seen. This may mean the presence of some iron oxide hydrate.



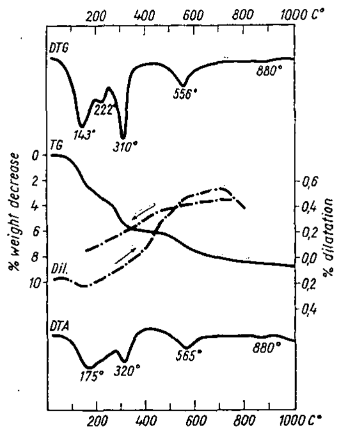


Fig. 12. Thermal curves of the Lower Pannonian clayey silt, from 15,0 m depth. No. L-9. boring. Lengyelszótető.
Fig. 13. Thermal curves of the Lower Pannonian clayey silt, from 11,0 m depth. No. L-7 boring. Lengyelszótető

The peak temperature, however, is somewhat lower than the values of goethite and lepidocrocite published in the literature. Therefore, the modification present may not be definitely identified. The iron content of such samples is considerable, at present $Fe_2O_3 = 9{,}58$ per cent.

X-ray examinations. To ascertain the quartz content, the crystal structure and mineral composition of the samples, X-ray diffractograms of 50 samples were studied. The results of these examinations are in good agreement with that of the thermal investigations. Feldspar is to be detected by X-ray examinations, whereas its thermal effect is not to be detected in the presence of illite. A small quantity of kaolinite could be determined in more than half of the examined samples. The presence of kaolinite could not be stated on the thermograms because of its poorly crystallization.

Investigation of soil mechanics. To define the state of morphology, plasticity of the materials characteristic for the area and for classification on the base of the grain size composition, the plasticity and grain size distribution were studied. The grain size distribution was determined by hydrometry in normal and peptized state.

The curves of grain size composition in *Fig. 14* show the extreme values in normal and peptized state. The difference between the two states may be explained by the strong coagulation of the clay particles in natural state. This feature is also characteristic of clay minerals with sorbed bivalent cations. The flat curves, reaching several ranges, illustrate the bad sorting of the sediments pointing to undisturbed conditions of sedimentation.

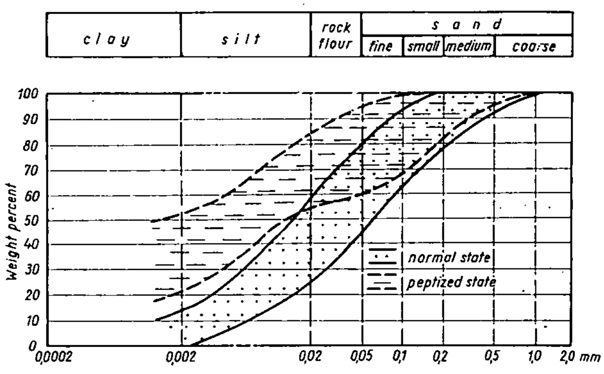


Fig. 14. Grain size curves showing only the extreme values

Some parameters well known in the soil mechanics were also determined in some of the samples collected from the Csoznyatető. These parameters are: liquid limit (F), limit of plasticity (P) and index of plasticity (P_i), value of linear shrinkage (Zs_l).

The results are summarized in *Table 2*.

TABLE 2

Symbol of the sample and the name of the rock	F %	P %	P_i %	Zs_1 %	Weight per cent of the clay fraction	
					natural	peptized
					state	
1	2	3	4	5	6	7
IX-00/11, 0 grey silty clay (*pa*)*	64,0	28,0	36,0	4,3	2	47
IX-00/15, 0 grey silty clay (*pa*)	60,5	27,7	32,8	8,3	3	45
IX-00/20, 0 grey silty clay (*pa*)	59,0	27,0	32,0	3,8	4	48
X-6/10,0 dark brown clayey silt with rock-flour (*pa*)	34,5	15,5	19,0	7,1	8	39
X-6/15,0 yellowish grey silt rock flour (*pa*)	35,8	20,0	15,8	8,8	0	40
X-6/20,0 yellowish-grey silt with rock flour (*pa*)	41,2	20,5	20,7	0	8,2	24
X-6/25,0 grey silt with rock flour (*pa*)	54,8	22,5	32,3	6,3	4	25
XVII-01/13,0 yellowish brown silty clay (*pa*)	46,0	18,6	27,4	5,7	15	51

* *Remark:* abbreviation (*pa*) means Lower Pannonian age.

SUMMARY

In both exploration areas, in the Lower Pannonian offshore, often lensed, cross-bedded strata near to the surface a raw-material resources of clay and clayey development, respectively, were discovered in considerable quantity.

According to chemical, instrumental as well as mechanical investigations the clayey raw-material discovered is very heterogeneous regarding its mineral composition. The three types of the clay minerals are to be found, beside the quartz, in the clay and in the strata of clayey development.

The material of the Csoznyatető area, nearer to the one time lakeshore is rather montmorillonite and that of the Lengyelszótető area, far from the shore, is to a greater extent an illite type clay mineral — after evidence of thermal and X-ray examinations.

REFERENCES

MIHÁLTZ—FARAGÓ, M. [1966]: Palynological Study of Lower Pannonian Strata in the Region of Görömböly. — Acta Univ. Szegediensis. Min. Petr. *18*. Szeged.

SCHRÉTER, Z. [1925]: Adatok a Sajómedence és a Bükk D-i oldalának geológiai viszonyaihoz. — Földtani Intézet Évi Jelentése 1920—23. 33—39. (Annual Report of the Hungarian State Geological Institute). Budapest.

SCHRÉTER, Z. [1939]: A Bükk-hegység délkeleti oldalának földtani viszonyai. — Geologische Verhältnisse der SO-lichen Seite des Bükk-Gebirges. — Földtani Intézet Évi Jelentése 1933—35. II. 511—532. (Annual Report of the Hungarian State Geological Institute). Budapest.

SCHRÉTER, Z. [1943]: A Bükk-hegység geológiája. — Földtani Intézet 1943. Évi Jelentésének függeléke. 378—411. (Appendix to the Annual Report of the Hungarian State Geological Institute) Budapest.

SCHRÉTER, Z. [1960]: Die geologischen Verhältnisse des Bükk-Gebirges. — Karszt- és Barlangkutatás, 1959. I. 7—36. Budapest.

TAKÁTS, T. [1964]: Kötőanyagipari nyersanyagok kutatása. — Az ÉaKKI tízéves tudományos működése, 1953—1963. 15—26. (Ten Years Scientific Research of the ÉaKKI) Budapest.

VITÁLIS, GY. [1965]: Cementipari nyersanyagok földtani kutatása. — Szilikáttechnika, 1965. 115—117. 129—132. Budapest.

VITÁLIS, GY.—HEGYI, J. [1965]: A Hejőcsabai Cement- és Mészmű agyag nyersanyag kutatásáról. — ÉAKKI Szilikátkémiai Osztály (Dept. of Silicate-Chemistry of the ÉaKKI), Manuscript. Budapest.